EFFECT OF TILLAGE AND SURFACE RESIDUES ON COTTON FIBER PROPERTIES

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INTRODUCTION

High-quality raw cotton is desired by spinners, weavers, knitters and textile manufacturers. Although much research has been conducted comparing conservation-tillage cotton yield to conventional-tillage yield (for example, McClelland et al., 1993), less information is available on how reduced-tillage technologies influence fiber properties. This information is needed to ensure that these new production technologies result in high-quality cotton.

Both genetic (e.g., variety) and environmental factors determine the physical fiber properties of cotton (Meredith, 1992). With the long flowering and boll-development time needed to produce an acceptable cotton yield, environmental conditions continually change as the crop develops during the growing season. This variation in environmental conditions is a partial cause of the range of fiber properties within the canopy as the bolls are produced up the main stem of the plants and outward on the branches. Tillage systems (Hoskinson and Howard, 1992) and surface residue amounts (Stevens et al. 1992) can influence the initiation of first square and the position of the bolls within the canopy. These changes may also impact the fiber properties of the harvested cotton. In addition, light reflected from bare soil has a different spectral balance than light reflected from crop residues on the soil surface (Hunt et al., 1989). Kasperbauer (1994) reported that the quality of light reflected from the soil surface impacted plant height, boll number and fiber length.

We routinely collect fiber property data from our conservation-tillage experiments at Clemson University's Pee Dee Research and Education Center in Florence, South Carolina. The purpose of this report is to summarize some of our findings.

EXPERIMENT DESCRIPTIONS

1991-1992

Treatments in the experiment were winter cover crop (cereal rye or fallow) and tillage system (conservation and conventional). The rye was fall planted with a grain drill at a seeding rate 120 lb seed/acre and allowed to grow until mid-April each spring. In mid-April, the amount of winter growth was measured. Each year, the amount of above-ground plant material grown through the winter was about 2200 lb/acre of rye and 1000 lb/acre of winter weeds (in the fallow plots).

After collecting the winter growth data, the conventional-tillage plots were disked twice, harrowed, and bedded. On the same day, the conservation-tillage plots received an application of paraquat to kill all vegetation. All plots were in-row subsoiled, and cotton (variety 'Coker 315') was planted in 38-in. rows in early May.

1993

Cotton was grown with conservation tillage under irrigated and dryland conditions following the harvest of winter crops. Each water regime had three levels of surface residue (none, low to moderate and abundant) achieved by seeding cotton after flax (cultivar 'Natasia'), winter weeds (fallow) and winter wheat (cultivar 'Coker 9835'), respectively.

When the winter crops were mature, the wheat plots were harvested for grain yield and the flax plots for straw and seed yields. After winter-crop harvest in early June, all plots were in-row subsoiled, and cotton (variety 'Stoneville 453') was then planted in 38-in. rows. Residue amounts were measured at 0 lb/acre for the flax (because seed and straw were harvested) and 3700 lb/acre wheat straw. Though not measured, winter weed residues appeared to be less than 1000 lb/acre.

Water (about 1.0 in. at each irrigation time) was supplied to the irrigated plots with a traveling gun. Irrigation scheduling was achieved by placing

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tensiometers in the plots (9 in. deep) and applying the water when tensiometers dried to 25 centibars.

1994

The same plots and experimental procedure as the 1991-1992 study were used in 1994. In addition, cotton seeded following a crimson clover cover crop (seeded at 20 lb/acre in the fall) was also evaluated. The amount of above-ground biomass of the winter covers tilled into the soil in the conventional-tillage plots was 3750 lb/acre of clover, 1400 lb/acre of winter weeds (fallow plots) and 3600 lb/acre of rye. In the conservation-tillage plots, biomass of the winter covers which were left as surface residues was 4100 lb/acre of clover, 1000 lb/acre of winter weeds (fallow plots) and 5200 lb/acre of rye. The cotton variety used in 1994 was 'DES 119'.

General to All Experiments

Clemson University production recommendations were followed for application of pesticides and fertilizers. Cotton was harvested with a two-row spindle picker for yield determinations. Grab samples from the harvest bags were saw-ginned, and fiber samples were sent to Star-Lab, Inc in Knoxville, Tennessee, for fiber property analysis. In 1991 and 1992, fiber length, strength (stelometer), elongation and micronaire were determined. In 1993 and 1994, these measurements, fiber uniformity and the fiber color determinations of Rd and Hunter's b were determined by High Volume Instrumentation (HVI).

RESULTS

1991-1992

Weather conditions in 1991 were good for cotton production. Even though differences in yield occurred between tillage and winter cover combinations, no differences in fiber properties were found (Table 1). An extended dry period occurred during July of 1992, resulting in substantially lower yields than in 1991. Because of the drought stress, micronaire was higher in 1992 than in 1991. Averaged over both winter covers in 1992, micronaire was about 0.15 units lower for the cotton produced with conservation tillage than for the cotton produced with conventional tillage. Neither tillage nor winter cover influenced the other fiber properties measured in 1992.

1993

Under irrigated conditions, surface residues did not affect any fiber property (Table 2). Yield of cotton following wheat and fallow was higher than yield of cotton following flax (Table 2). Under rainfed conditions, cotton yield did not differ among the three surface residue treatments (Table 2). As in the 1991-1992 study, most fiber properties were not affected by the surface residue treatment. Micronaire of non-irrigated cotton, though, was lowest for the cotton grown following wheat, and it was significantly (at the 95% probability level) lower than for the cotton following fallow.

1994

As in 1991, weather conditions in 1994 were favorable for cotton production, and lint yields were good. Within a tillage system, none of the fiber property measurements were influenced by winter cover (Table 3). Averaged over all three winter cover treatments, cotton from conservation tillage was 1.0 gram/tex stronger and had a higher Rd value (was whiter) than the cotton from conventional tillage. None of the other fiber properties were influenced by tillage.

A possible problem for conservation-tillage cotton grown with large amounts of surface residues is high trash content in the fiber. Trash level measurements were made (data not shown) only in 1994. Even though there were considerable amounts of rye residues remaining on the surface (with some still standing to a height of 1.5 ft) in the conservation-tillage plots, there was no significant difference between treatment combinations for percentage trash. More data are needed to verify these results.

SUMMARY

Our data indicate that most fiber properties are not substantially influenced by tillage system. Fiber length and elongation were not affected by tillage system or surface residue cover in any of our studies. Conservation-tillage cotton had higher fiber strength in 1994; otherwise strength was also not affected by tillage system.

High micronaire is a particular concern for some areas of the Cotton Belt in the southeastern U.S., especially during dry years. When water stress occurred in our studies, ample surface residues with conservation tillage tended to result in slightly lower micronaire. This slight reduction may help prevent cotton from being graded as high mike in some years.

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Table 1. Influence of tillage and winter cover on 'Coker 315' cotton fiber properties and yield in 1991 and 1992.

		Conservation Tillage		Conventional Tillage		
Year	Variable	Fallow	Rye	Fallow	Rye	LSD[z]
1991	Elongation (%)	7.4	7.3	7.3	7.4	ns
	Strength (gms/tex)	20.0	20.4	20.1	20.1	ns
	Length (in.)	1.14	1.15	1.15	1.15	ns
	Micronaire (units)	4.2	4.3	4.3	4.2	ns
	Yield (lb/acre)	850	1177	1008	1234	381
1992	Elongation (%)	7.2	7.1	7.3	7.4	ns
	Strength (gms/tex)	20.8	21.4	21.4	20.6	ns
	Length (in.)	1.15	1.16	1.16	1.17	ns
	Micronaire (units)	4.6	4.4	4.7	4.6	[y]
	Yield (lb/acre)	238	437	397	501	129

[z]Means are statistically different if they differ by the LSD amount; ns indicates they are not different at a 95% probability level.
[y]Averaged over both winter cover treatments, conservation tillage had lower micronaire than conventional in 1992 (4.5 vs 4.65 mike units).

Table 2. Influence of surface residues on HVI fiber properties and yield of 'Stoneville 453' under irrigated and rainfed conditions in 1993.

	Previous Crop			
Variable	Wheat	Flax	Fallow	LSD[z]
Irrigated				
Elongation (%)	10.0	10.0	10.0	ns
Strength (gms/tex)	25.8	25.3	25.5	ns
Length (in.)	1.14	1.13	1.13	ns
Micronaire (units)	4.0	4.0	3.9	ns
Uniformity (%)	83.0	82.7	82.4	ns
Rd (%)	63.8	60.6	59.1	ns
Hunter's +b	6.7	6.8	6.9	ns
Yield (lb/acre)	954	769	909	122
Rainfed				
Elongation (%)	10.0	10.0	10.0	ns
Strength (gms/tex)	25.7	26.0	26.2	ns
Length (in.)	1.13	1.14	1.14	ns
Micronaire (units)	4.3	4.5	4.7	0.36
Uniformity (%)	82.2	82.2	82.3	ns
Rd (%)	55.1	58.7	57.1	ns
Hunter's +b	7.0	6.5	6.7	ns
Yield (lb/acre)	617	636	656	ns

[z]Means are statistically different if they differ by the LSD amount; ns indicates they are not different at a 95% probability level.

Table 3. Influence of tillage and winter cover on cotton HVI fiber properties and yield of 'DES 119' in 1994.

	Conservation Tillage			Conventional Tillage			
Variable	Fallow	Rye	Clover	Fallow	Rye	Clover	LSD[z]
Elongation (%)	10.3	10.3	10.3	10.2	10.3	10.5	ns
Strength (gms/tex)	25.2	25.4	26.0	24.5	24.9	24.6	[y]
Length (in.)	1.17	1.16	1.17	1.18	1.17	1.18	ns
Micronaire (units)	4.5	4.5	4.3	4.3	4.4	4.5	ns
Uniformity (%)	85.2	84.5	85.2	84.6	85.3	85.2	ns
Rd (%)	62.7	65.2	65.5	61.7	63.1	62.5	[x]
Hunter's +b	7.2	7.7	7.3	7.8	7.3	7.3	ns
Yield (lb/acre)	1269	1004	826	1083	1204	914	174

[z]Means are statistically different if they differ by the LSD amount; ns indicates they are not different at a 95% probability level.
[y]Mean strength for conservation tillage is higher than for conventional tillage ($P = 0.01$) (25.7 gms/tex vs 24.7 gms/tex).
[x]Mean Rd for conservation tillage is higher than for conventional ($P = 0.05$) (64.4% vs 62.9%).